COMMONWEALTH OF THE PHILIPPINES
DEPARTMENT OF AGRICULTURE AND COMMERCE
BUREAU OF MINES
MANILA

INFORMATION CIRCULAR No. 2

PRELIMINARY REPORT ON MANGANESE ORE BENEFICIATION AT GRAWFUS MINING COMPANY, DIRIQUE ILOCOS NORTE

By

W. F. BOERICKE AND N. N. LIM

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PRELIMINARY REPORT ON MANGANESE ORE BENEFICIATION AT GRAWFUS MINING COMPANY, DIRIQUE, ILOCOS NORTE

By W. F. Boericke and N. N. Lim
Of the Bureau of Mines, Manila

This property was inspected during May, 1938, for the special purpose of studying the beneficiation methods employed at the mine to raise the grade of the crude ore. Acknowledgment is made to Mr. Thomas Jurika, Superintendent at the mine, for full coöperation in furnishing all operating data requested.

ORE OCCURRENCE

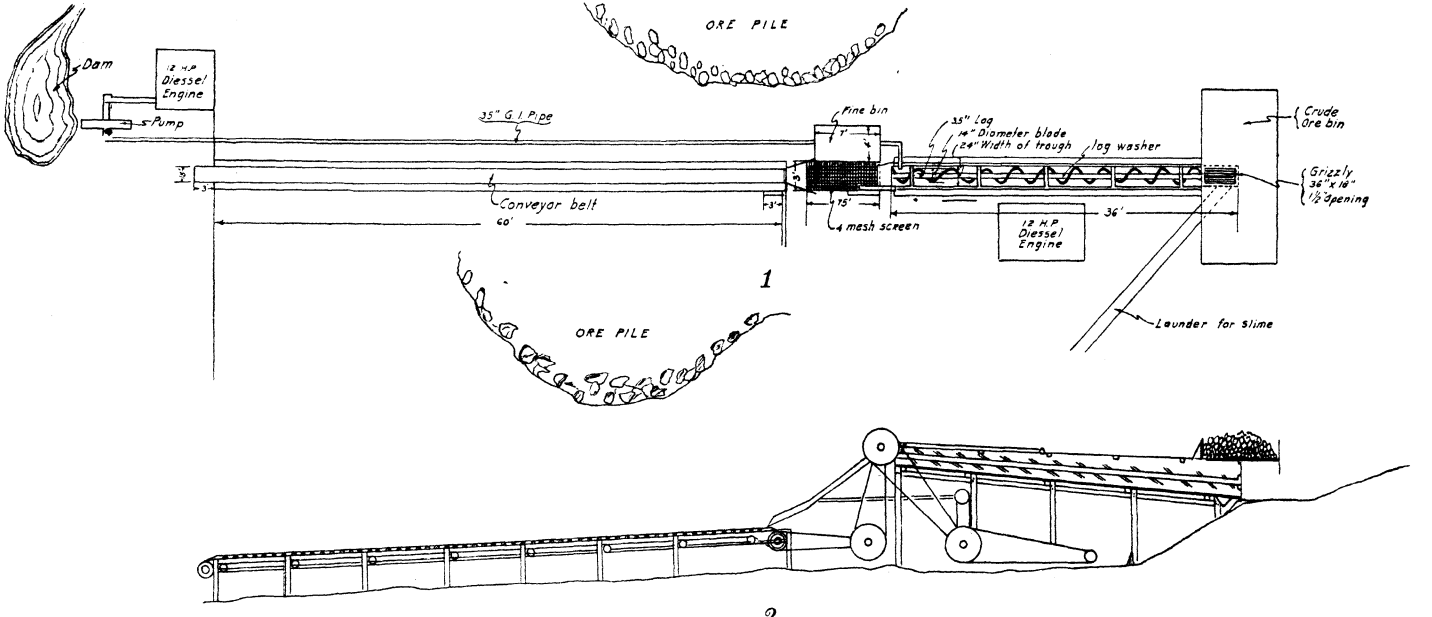
In the main the ore appears to be residual, surficial deposits irregularly distributed in patches over a barren bottom of clay, associated with boulders of country rock. The extent of the deposits is extremely difficult to estimate, as very little testing has been done in advance of the workings. However, ore is being mined from many different places, and the known mineralized area is tolerably well delimited adjacent to the camp. It appears probable to us that the estimate of the management that 10,000 to 15,000 tons of recoverable ore are assured is conservative. The manganese is mainly nodular in character and occurs in the clay, but there is some higher grade material that requires selective mining. All ore is mined by hand, some under contract, but mainly by day's pay. About 125 men and women are employed.

In addition to the ore that goes to the log washer there is a large amount estimated by the manager in excess of 50,000 tons of so called "yellow coated" material, consisting of nodules and pebbles of pyrolusite coated with a thin layer of limonite, or iron stained silica or lime. This material cannot be beneficiated by washing, and is said to contain about 28 per cent Mn and 15 to 20 per cent silica.

All mining is open pit; there is no attempt to use underground methods. Most of the working faces are 4 to 6 feet high, but this height is exceeded in some places. Boulders occur frequently in the clay and interfere with mining, and may give a deceptive impression that the bottom of the deposit has been reached, especially in test pitting.

PRODUCTION

Ore is being mined from a dozen or so different points, within a short distance of the camp and transported to the log washer by trucks. Capacity of trucks is estimated at 2½ tons.



LOG WASHER PLANT, GRAWFUS MANGANESE COMPANY

FIG. *1*, The plan; *2*, cross section.

SCALE: 1" = 20'

PLATE 1

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When water is scarce, as at the present time, a portion of the ore is trucked to Dirique, seven kilometers distant, and washed there with sea water. All of the washed product from the log-washer is taken to Dirique for shipment on lighters, but an attempt is being made to beneficiate the fines from the log washer by jigging before shipment.

At the time of this visit, the log washer was treating 42 tons of crude material per 8-hour shift (17 truck loads). The capacity, with plenty of water, is considerably larger than this.

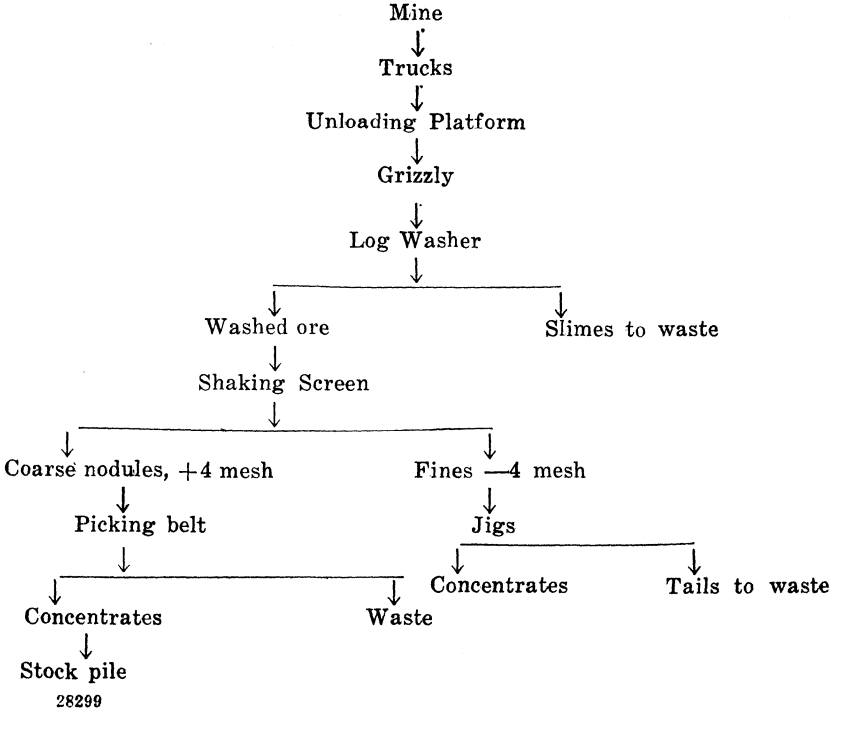
Following are the results of 8 hours' operation:

		Assay
Tons to log-washer	42.0	29.3% Mn
Tons oversize material (nodules)	20.5	34.0% Mn
Tons undersize, —4 mesh	9.5	24.1% Mn
Tons slimes	12.0	25.3% Mn (by calculation)

As the —4-mesh material is too low in grade to be of commercial value, and must be discarded unless further beneficiated, we have for the nodular material only:

Concentration ration 2.05:1
Recovery 56.6%

Flow Sheet of Beneficiation



GRIZZLY

This extends across the unloading platform, and consists of 2-inch railroad rails spaced 1½-inches, 22 inches wide. Thus the material fed to the log washer is limited to 1½-inch size.

LOG WASHER

This construction follows conventional lines. The washer is set on a 4-degree slope (7 per cent grade, or about ¾ inch to the foot).

GENERAL SPECIFICATION OF LOG WASHER

Length—32 feet.

Width of box—22 inches at top, with 2-inch lining boards on bottom and sides, which in turn are lined with iron sheets.

R. P. M.—20 (usual speed recommended is 12 to 15 R. P. M.)

Size of shaft—3½ inches.

Drive—by bevel gear, belt driven from jack shaft to diesel.

Spiral blades—⅛-inch iron, 5¼ inches high or 14-inch overall diameter, set spirally on shaft, with a pitch of 14 inches.

Power required—A 12-H.P. diesel engine drives the log washer, operates shaking screen and conveyor belt.

Water required—Estimated at 50 g.p.m. Water is fed at the discharge end of the washer, as well as in the middle from 1½-inch pipes running full, and carries the slimes and clay away at the front, or feed end, in a tailings trough to waste. No attempt is made to re-use water by settling.

Operation—Crude ore, which may or may not have been dry-screened and hand-picked, drops through the grizzly on to the ascending spiral blade, and is worked up toward the discharge end, becoming thoroughly washed and disintegrated in the process. No supervision is required. At the discharge end, cleaned ore drops on a shaking screen. Clearance between bottom of trough and revolving spiral is greater than diameter of largest lump of ore, hence there is no crushing action.

Capacity—Stated to be 45 tons of *washed product* in 16 hours. At time of visit, 42 tons were washed, from which were obtained 20.5 tons of nodular, or coarse, concentrates and 9.3 tons of fines. Due to shortage of water the log washer was running at less than usual capacity.

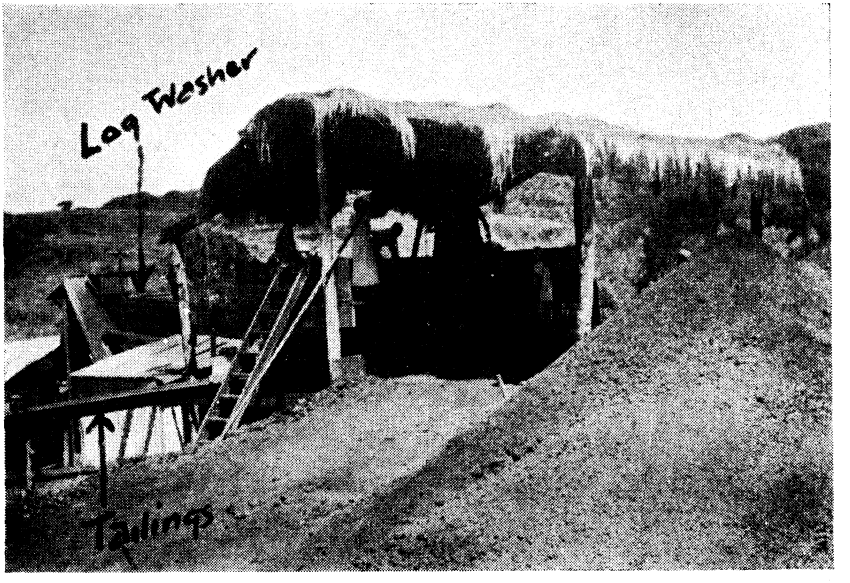


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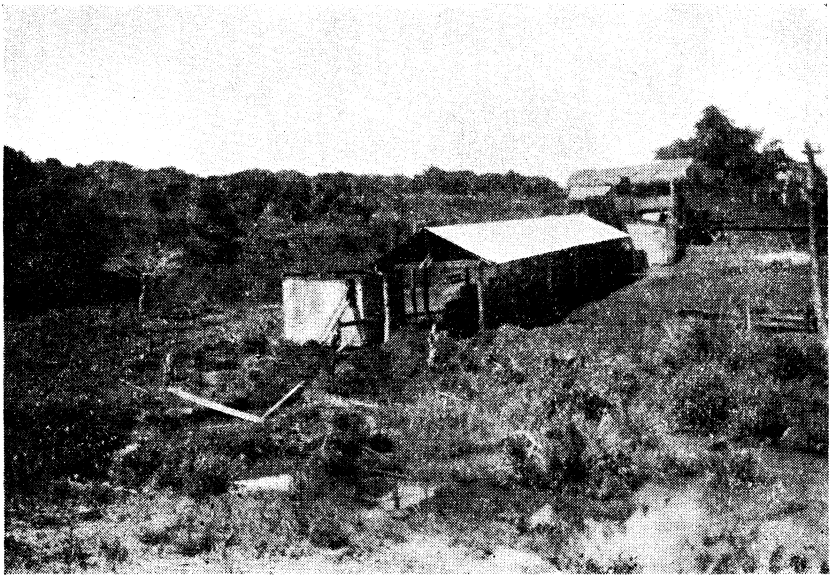
FIG. *1*, Upper end of beneficiation plant; *2*, lower end, showing picking belt.

PLATE 2



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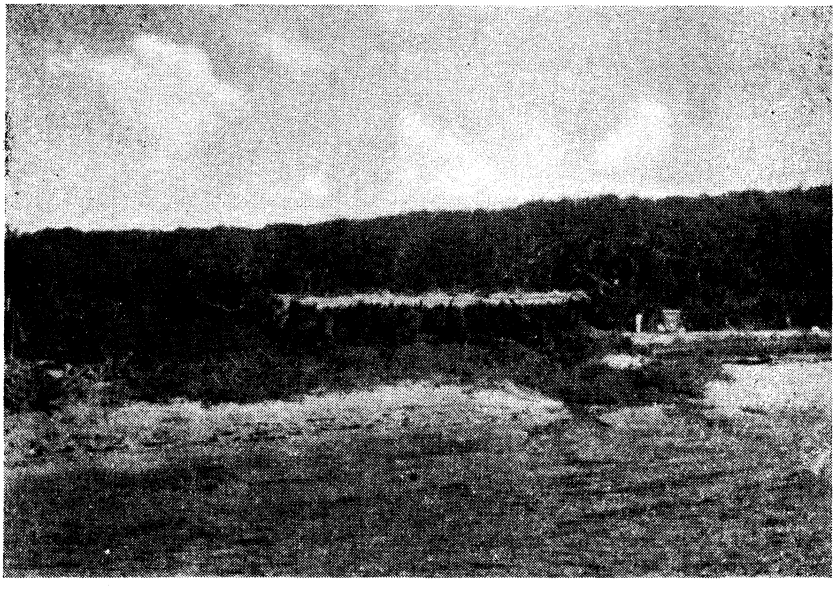

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FIG. *1*, General view of beneficiation plant; *2*, washing tables and jigs at Dirique.

PLATE 3

GENERAL SPECIFICATIONS OF SHAKING SCREEN

Size—8 feet by 32 inches.
Stroke—2-inch, from eccentric on jack shaft.
Vibrations—180 strokes per minute.
Size—4 mesh ($\frac{3}{16}$-inch hole approximately).

GENERAL SPECIFICATIONS OF CONVEYOR OR PICKING BELT

Length—56 feet.
Width—18 inches, 4-ply rubber.
Speed of travel—14 feet per minute.
Slope—8.7 per cent.
Number of pickers—28 (women).
Amount of waste removed per 8-hour shift—2 tons.

OTHER BENEFICIATION

Because of shortage of water at the camp, the fine concentrates are taken to Dirique for jigging where the sea furnishes a water supply. Cost of trucking from the camp to Dirique, 7 kilometers over a hard-surfaced road, downhill grade, is ₱1.10 per ton.

JIGGING

Fines are treated on a standard 2-cell Hartz jig. Cells are run as units, not in series; that is, there is no attempt to operate one as a rougher, the other as a cleaner.

Feed is conveyed to platform by wheelbarrow, and shovelled into jig beds by hand. An effort is made to keep feed regular and steady. Two men are on the jigs. Power is supplied by a 12-H.P. diesel to a jack shaft, which drives the jigs and operates a 4-inch centrifugal pump. Besides a water spray into the feed box at the head of the jigs, it is also fed into the plunger compartments of each cell.

GENERAL SPECIFICATIONS OF JIGS

Size of compartments—Feed side 29 in. by 24½ in.
Stroke—$\frac{3}{16}$-inch, 220 per minute.
Size of feed—4 mesh.
Bed—Artificial, thickness 4½ inches, using ½″ to ¾″ material.
Capacity—Reported as maximum of 8 tons of feed per 8 hours through both cells (4 tons each), but at time of visit capacity was much less, due to shutdowns and endeavor to improve work of jigs.

Production—At time of visit 36 wheelbarrows of cleaned concentrates were made in 8 hours, equal to 3,960 lbs., or 1.8 long tons.

SPECIFIC GRAVITY

Determinations were made on various products:

No. 1—Small nodular piece from log washer	2.46
No. 2—Small nodular piece from log washer	3.01
No. 3—Pure nodular material, small piece, sp. gr. determined by water displacement	2.77
No. 4—Same material, large piece	2.73
No. 5—Same material, laboratory determination, 5 minutes allowed for air displacement by water	2.84
No. 6—Reject from log washer, hand picked	2.35
No. 7—Reject from log washer, hand picked	2.29
No. 8—Pure nodular material, fine ground, —20 mesh all air bubbles removed, sp. gr. determined by careful laboratory apparatus	3.40

COMMENT

It is particularly interesting to note that the specific gravity of the larger pieces is much less than that of the fine ground material. This plainly indicates *porosity* of the larger pieces, which makes them relatively lighter than small particles. As jigging must be confined to relatively coarse-sized particles, the difficulty of attempting to make a separation of the manganese from lime or silica is apparent. Any attempt to improve the work by ordinary adjustments, such as by varying the stroke, increasing or decreasing hydraulic water, etc., can give no assurance of success when the basic condition for successful jigging, a notable difference in specific gravity of concentrate and waste, is absent.

Washing tables.—At Dirique six stationary washing tables are being used with sea water to clean surplus ore, which cannot be taken to log washer on account of water shortage. These tables consist of a troughlike rectangular box, 12½ feet in length and 40 inches wide, with a slope towards discharge end of about ½ inch per foot.

Ore is shovelled into the box at far end, which has a 4-mesh screen to hold back material, and worked up by hand to the front, ore being constantly shovelled over under water. Final cleaning is done in a 2½-foot box with 4-mesh screen under a water spray.

There are three women employed on each table to wash the ore. Capacity of each table is 2 tons in 8 hours.

SUMMARY

The samples taken do not show the general character of the feed nor the nodular concentrates, which are of a considerably higher grade, as shown by assays of two weeks' run, from the company's assayer.

These samples indicate an average grade of 38.7 per cent Mn, varying from 34.3 per cent to 42.6 per cent Mn. It is evident that the grade of the washed nodular product (plus $\frac{3}{16}$-inch) depends largely on the grade of the crude ore. It is also clear that the grade of the fine product (minus $\frac{3}{16}$-inch) is much lower than that of the nodular, indicating that the larger sizes contain relatively less silica, lime, and clay than the smaller size.

The recovery of the manganese by the log washer is only 56 per cent, indicating large losses in the fines and slimes. The manganese content of the nodular product is increased during the washing by about 5 or 6 per cent. That is, if feed comes in averaging 36 per cent Mn, the nodular product is about 42 per cent, and if it averages 29 per cent, the final product is about 34 or 35 per cent Mn.

The direct loss of manganese in the slimes that are carried away in the tailings launder may be calculated thus:

	Tons.
Manganese content of feed 42 x 29.3%	12.3
Manganese content of coarse concentrates 20.5 x 34%	6.97
Manganese content of fine concentrates 9.5 x 24.1%	2.29
Total manganese recovered	9.26
Total manganese lost in slimes 12 x 25.3%	3.04

Per cent manganese lost in slimes 24.7%.

Due to the nature of the crude ore, which appears to be porous and of low specific gravity, much low-grade ore is carried away in the tailings. It also appears that the larger pieces of ore are intimately mixed with impurities, and the latter cannot be removed by washing, scrubbing, or handpicking to raise the grade much over 40 per cent.

It is possible that crushing the ore to finer size with subsequent classification and tabling, might result in obtaining a higher grade product, although there would no doubt be a heavy sliming loss. There is further the question of sale of a finely ground product, which is undesirable for some buyers, and this matter should be carefully considered. However, there appears to be a much greater likelihood of separating manganese in fine sizes, with a specific gravity of 3.4 from silica or lime with 2.6, than there is of jigging the coarse sizes where

the ratio between the specific gravity of the manganese and waste appears to be in the order of 1 : 1.4 instead of 1 : 1.85 for the fines. (See Taggart, Ore Dressing, pp. 11.)

If this problem is to be considered, detailed microscopic work upon the ore is required, along with complete chemical analyses of the various sized products in order to determine what beneficiation is required, and what practical steps might be taken to accomplish it.

It should be noted that there is no assurance that the principal proportions of the material do not contain silica or lime so intimately mixed with the manganese as to make separation by any mechanical means economically impossible. However, this is to be determined, and there is no data at hand that indicates it would be impossible.

It appears worthy of note that the moisture content of the feed is only 5.85 per cent in feed and 5.2 per cent in washed nodules.

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